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ABSTRACT

This collection of four essays examines the ways in which biology, as a discipline, reflects ongoing scholarship on gender, race, ethnicity, social class, and sexual orientation. In "Natural Sciences: Molecular Biology," Bonnie B. Spanier examines common ideological distortions in biology, including superimposing stereotypical gender attributes and language onto animals and plants, creating hierarchies of organization with assumptions about power relationships, and claiming that biology determines behavior. In "Feminist Critiques of Biology," Sue V. Rosser discusses the inequities of scientific research and education and ways in which feminist perspectives can be introduced into biology courses. In "Balancing the Curriculum in the Biological Sciences," Joseph N. Muzio discusses the teaching of a Biology of Women course and offers insights on how it affects students' understanding of women's issues and feminist perspectives of science. In "Women in Science and Engineering," Edward B. Tucker points out that while the number of women in science and engineering has increased significantly over the last decade, women have tended to attain degrees and academic positions in life science and psychology rather than in earth science, environmental science, mathematics, and engineering. Each essay contains references. (MDM)

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BIOLOGY

CUNY Panel:
Rethinking the Discipline

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WOMEN in the CURRICULUM

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Women in the Curriculum

BIOLOGY

CUNY Panel:

Rethinking the Disciplines

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PREFACE

In the fall of 1992 the SEMINAR ON SCHOLARSHIP AND THE CURRICULUM: THE STUDY OF GENDER, RACE, ETHNICITY, AND CLASS, under the aegis of the **City University of New York Academy for the Humanities and the Sciences**, and generously funded by the Ford Foundation, undertook a series of meetings devoted to "Rethinking the Disciplines." The Academy Seminar had already spent four years examining ways in which the study of gender, race, ethnicity, and class has slowly been transforming the curriculum of the university. Panels had explored women's studies, ethnic studies, area studies, interdisciplinary studies, pedagogical issues, and teaching about such topics as AIDS. The Academy Seminar draws upon faculty at CUNY who are members of the CUNY Academy, and upon those interested in these specific issues and those who have themselves taken part in one of the several curriculum transformation projects within CUNY beginning in the 1980s.*

* Two at Hunter College beginning 1983 among those teaching introductory courses and in 1985 among faculty in the professional schools; two sponsored by the Center for the Study of Women and Society with Ford Foundation grants for the Community Colleges and for Integrating Materials on Women of Color into the Senior Colleges; four semester-long seminars funded by the New York State Department of Education's Vocational Education Program for technical and vocational education faculty within the University; and six year-long seminars organized by the Office of Academic Affairs of the University for Balancing the Curriculum for Gender, Race, Ethnicity, and Class.

It was timely, therefore, that in its fifth year the Academy Seminar should ask directly how much the new theory and curriculum changes that have been identified over the years have actually affected the pursuit of our disciplines. The four areas targeted—Literature, History, Sociology, and Biology—represent disciplines in which a great deal of "theory" now exists, new journals have proliferated, and considerable work has been done under many aegises to identify, explicate, and disseminate the transformed perspectives that have been formulated. There is no lack of materials now, no absence of theoretical frameworks, no question of the level of sophistication and argumentation, and no dearth of pedagogical analyses demonstrating the importance of these new methodological approaches, this new knowledge base.

For BIOLOGY, each panelist was asked to consider the issues from a set of questions framed to bring forward what is happening from her or his perspective in the discipline. These questions probe the ways biology currently reflects the ongoing scholarship on gender, race, ethnicity, and class: Have there been any shifts in the ways research is taught to graduate students in this field, for example, or are the questions asked by the discipline in any way different? If there have been changes, have they begun to show up in introductory textbooks?

More fundamentally, do our panelists believe that there have been efforts to reconceptualize the discipline? If, on the other hand, panelists think disciplinary changes have been minor, do they care to comment on why—in the light of so much new scholarship on gender, race, ethnicity, and class, changes remain marginal to the practice of the discipline?

Has our new wealth of knowledge affected our teaching? Has it accomplished any significant paradigm shifts in traditional disciplines?

Dorothy O. Helly

Series Editor

April 26, 1993

Biology

Natural Sciences: Molecular Biology

Bonnie B. Spanier

Ideologies That Constrain the Natural Sciences

Among the traditional disciplines in the academy, the natural sciences tend to be slow in recognizing and attempting to correct cultural distortions of our systems of knowledge (such as the belief that women are inherently inferior to and different from men in behavior).[1] Scientists as a group are less apt to embrace the view that scientific knowledge, like all knowledge, is socially constructed by, for the most part, a small portion of the population and that it reflects the experiences, beliefs, and biases that serve that tiny but powerful population; scientists, that is, tend to embrace a positivist notion of "truth" rather than an understanding of scientific knowledge as highly political and socially constructed.

Traditional history, philosophy, and even sociology of science have reflected and perpetuated this view, until recently. Nonetheless, many *individual* scientists and educators have been working on reorganizing science curricula to reflect social and political concerns and the major challenges of our time (pollution, health, energy, etc.).

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A welcome effort to place science into a visible context has arisen from concerns about scientific human power needs. Fueled by pressures of economic competition, especially from Japan, in relation to technological and industrial production and concomitant increases in nationalistic chauvinism over U.S. preeminence in science, a national crisis in scientific literacy has been declared. The organization that represents the largest number of scientists in the United States, the American Association for the Advancement of Science (AAAS), has responded with a major project to transform the national science curriculum in public schools. If successfully implemented, this curriculum is sure to serve as an impetus to change in science education at the college level as well.

What is striking about the AAAS' Project 2061 is that it includes just those elements of science education that have been, for the most part, left out by most science educators as "not science" but emphasized in the new social studies of science and women's studies: the dynamic interdependence of science and the society that creates it. Thus, among the basic recommendations for scientific literacy are not only "Understanding key concepts and principles of science," as expected, but also:

> Knowing that science, mathematics, and technology are human enterprises and knowing what that implies about their strengths and limitations;
>
> Using scientific knowledge and ways of thinking for individual and social purposes.

This is a welcome effort for educators like myself and those engaged in potentially transformative projects. My experience teaching both biology (molecular biology, microbiology, and biochemistry) and women's studies courses (in particular on women, gender, and science),

highlights the clash of the prevailing values in science and the ideals of the humanities. I have found that students trained in the sciences find it difficult at first to overcome a passive, nonexpert stance and place themselves and their views into assignments about science in a social context.

The Resisting Reader and Feminist Perspectives in Science

"Literature is political," declares Judith Fetterley in the opening sentence of *The Resisting Reader: A Feminist Approach to American Fiction* (xi). That "science is political" may be acknowledged by science educators, but only in a limited sense. Support for this generalization is found in the major textbooks in molecular biology: they include no discussion of debates about the safety and ethics of recombinant DNA experiments and applications (Spanier *a,b*). While many scientists may admit that funding for research is somewhat "political" because a few powerful individuals in science determine the current topics for research, what I think most scientists disallow is the view of the new social studies of science (including feminist critiques) that all aspects of science, like any other human endeavor, embody and reflect power relations—the usual inequitable ones.

Fetterley's "resisting reader" is a woman coming to consciousness about the predominance of a particular white, Western male value system (termed masculinism) based on those males' experiences or, more often, their fantasies in the American literary canon. Conscious resistance against the dominant value system is essential to prevent what happens to women and other subordinated groups in a society: we internalize those demeaning values about ourselves, so that low self-esteem and even self-hatred

undermine us. Consequent socialization to masculinist values brings women into line, makes us complicitous with the status quo of unequal power relations. Thus, studies of science students suggest that, even if the structural barriers that block many women and minority students from pursuing science were removed, the lower self-esteem and confidence of women equally qualified with men would keep women from claiming an equitable place in science and other male-dominated professions (Zappert and Stanbury).

The Resisting Reader exposes the ideology embodied and maintained in the canon of American literature. For similar purposes, science education can (and, I believe, must) encourage "resistance" in science students and their teachers. Actually, I believe that this constructive, critical stance fits well within the theoretical objectives of science: to eliminate biases in our understanding of nature. A healthy scientific skepticism should involve questioning assumptions about factors affecting research design, paradigms, and conclusions. Just such a proposal has been made by Scott Gilbert and colleagues, using the language of experimental control in the scientific method, to persuade scientists to take feminist critical perspectives into account:

> Whenever one performs an experiment, one sets up all the controls one can think of in order to make as certain as possible that the result obtained does not come from any other source. One asks oneself what assumptions one is making. Have I assumed the temperature to be constant? Have I assumed that the pH doesn't change over the time of the reaction? Feminist critique asks if there may be some assumptions that we haven't checked concerning gender bias. In this way feminist critique should be part of normative science. Like any

> control, it seeks to provide critical rigor, and to ignore this critique is to ignore a possible source of error. (The Biology and Gender Study Group, 61-62)

The Discourse of Molecular Biology

Several common types of ideological distortions are found in biology. These include: (1) superimposing stereotypical gender attributes and language onto animals and even plants; (2) creating hierarchies of organization with assumptions of centralized control, casting power relationships of domination and subordination as natural products of evolution; and (3) claiming that biology determines behavior.

But how could such culturally generated distortions occur in the field of molecular biology, where the subject matter is not gendered animals but supposedly nongendered cells, genes, and macromolecules (large molecules such as DNA and proteins)? Molecular biology is of particular interest because it illustrates the impact of our dominant ideology of "difference" on nongendered subject matter. Further, this field demands our attention because it has taken a dominant position in the life sciences since the 1960s.

Distortions similar to the common types of biases listed above emerge from my feminist analysis of language, concepts, and organizing principles in molecular biology. Here are three examples of inaccurate representations of the microscopic and submicroscopic worlds, misrepresentations that have broad ramifications.

1. In the first example, bacteria are misrepresented as "male" or "female," a case of superimposing the stereotypical gender dichotomy onto nongendered beings.[2] Bac-

teria are called "male" or "female" based on the presence (male) or absence (female) of a "fertility" (or F) plasmid, a tiny piece of DNA like a separate chromosome, and a bridge (pilus) that links the two "mating" cells and allows the transfer of some genetic material from the male to the female. In this process, the receiving bacterial cell (the "female") gains a copy of the F plasmid and, hence, becomes "male." The scientific definition of "sex"—exchange of genetic material between organisms—has thus become confused with the cultural sense of "sex." The male-female designation is incorrect, since bacteria do not make eggs or sperm (the scientific basis for sex-designation). It is also sexist in its gender association of presence and absence, active and passive and heterosexist in its assumption that "sexual" interchange occurs only between a male and a female.

It is easy to understand why such gender attributions might be considered harmless, cute, and even useful for stirring interest in an otherwise dry subject, but we must recognize the way that such language reinforces sexism. Feminist analyses suggest that it is no accident that a gender ideology of essential male and female difference, with the male signified with the *presence* of the F plasmid and the pilus and as the natural initiator of action gets embedded in the study of bacteria, so deeply held or unquestioned is our culture's belief that male-female difference is fundamental to nature. The propensity for and tenacity of genderizing nongendered beings, reflected here in the natural sciences, suggests both the power and the function of gender ideology in our culture. Unintentional as it may be, it nonetheless promotes a biological determinist view of "gender."

2. In a second example, the relationships among elements are misrepresented as being hierarchical, under the control of one central "master" when they could just as

easily, and more accurately, be presented as interactive and non-hierarchical. In the past two decades, molecular biology has embraced complexity and interaction as key characteristics of life. Yet the textbook language describing the fundamental principles of the field of molecular biology is one of control of the genes over everything else in the cell:

> The modern era of molecular cell biology has been mainly concerned with how genes govern cell activity . . . [By 1952] a small group of informed scientists knew that DNA was the controlling molecule of life (Darnell *et al.*, 11).

In contrast, the following quote from the same textbook illustrates the language used to describe the essential function of proteins: "proteins . . . work together to make a living cell" (viii). Thus, DNA controls, while proteins work. Proteins sound suspiciously like laborers who keep things going, while DNA contains the important information, the "blueprints," for controlling the cell from the nucleus where DNA is contained in the chromosomes. Indeed, the most common term used for proteins is "gene products," defining proteins in terms of their subordinate relationship to genes.

The feminist argument that unequal power relations carry gender associations through the history of "Western civilization," usually traced back to Aristotle's expressions of misogyny, should be sufficient to appreciate the masculinist ideology built into singling out one component of the cell as controller of the life of the cell. But, in addition, recent historical studies provide evidence that scientists indeed have gendered the relationship of the nucleus and genes to the cytoplasm and proteins.[3]

Masculinist privileging of DNA as the "master molecule" (Keller, chaps. 8-9) that controls the components of

the cell in hierarchical fashion has not changed from the heyday of the 1960s, even though molecular biology has developed a language that acknowledges complexity in genetics and reciprocity of regulation. Alternatives to this hierarchical model of centralized control are not hard to find. It is just as accurate to say that proteins, in their ability to function as enzymes, in their contributions to enzyme action in structural, positional ways, also "control" genes. Furthermore, a tiny ion of magnesium also "controls" the gene by being essential for replication and other activities of genes. Indeed, using the key concept of "regulation," the activities of "life" may be characterized by being totally intertwined such that almost everything regulates almost everything else. To choose one component over all others as "primary" may be a useful heuristic device, but the language and basic principles of early and later molecular biology clearly use the primacy of DNA as a central tenet that then organizes not just the components of the cell, but all of biological knowledge. Thus, we find a hidden epistemological stance: that DNA determines what constitutes knowledge —knowledge in the study of "life" and "knowledge" in the cell.[4]

3. In a third example that encompasses the intertwined problems of (a) inaccurate dualisms such as nature versus nurture, and (b) biological determinism, cancer is misrepresented as a disease that has solely physiological, genetic origins, rather than the result of economic, political, and social forces. One of the consequences of the distortion in molecular biology is evident in common textbook descriptions of cancer, in which the basic question guiding the approach to understanding cancer is: How do genes control everything in the cell?; and the guiding methodology is recombinant DNA technology that sequences DNA and proteins. Cancer is considered primarily through the lens of molecular genetics because of the "extraordi-

nary power" of those tools (Darnell *et al.*, chap. 24; Watson *et al.* pt. X). While that methodology has provided much information about a genetic analysis of cancer, it is incorrect to then assume that a genetic analysis is the *most* important one for understanding what causes cancer and how to prevent or cure it. Consider the difference between thinking that cancer is primarily a problem of an individual's unfortunate genetic makeup rather than a problem influenced significantly by cancer-promoting chemicals and irradiation in our air, water, and food produced in good measure by industrial processes, and societal conditions and habits (and even the scientific experiments in this field that use radioactive and carcinogenic chemicals).

Readers (undergraduate science majors, medical students, and graduate students) of these quoted texts are not encouraged to consider the importance of factors that we know contribute to cancer in various populations. Not only does our scientific understanding of this disease suffer as a consequence of research pro-grams coming out of this view, but this genetic/nongenetic form of the nature/nurture fallacy privileges the promise of a gene therapy approach to curing cancer while underplaying the data that a large majority of human cancers are caused or promoted by environmental carcinogens in our air, water, food, and workplaces. The future researcher is encouraged by example to ignore major economic, political, and social forces that contribute significantly to this disease rather than thinking of cancer as a disease not only of whole living/dying beings, but of society.

Thus, despite the move away from the previous simplistic and reductionist conflation of bacteria with larger organisms, a belief in centralized control and unequal power relations remains the overriding paradigm in molecular biology textbooks and scientific literature. The predomi-

nant meaning of "difference," even in progressive texts, carries strong overtones of "better than" and "power over," along with "fixed and hereditary," biologically determined by "genetics." With a natural hierarchy of power reinforced at yet another level of our worldview, all ideologies of "difference" are further cemented into a superior/inferior relationship. Feminist analyses of this discourse demonstrate how deeply pervasive are such beliefs about natural differences. To introduce into the biology curriculum such analyses of textbooks would, I suggest, give voice to many views in the classroom, but it would require a shift in emphasis, content, and ideology in the curriculum.

Who Will Do Science?

At the risk of overgeneralizing about the state of science education and the practice and communication of science among professional scientists (researchers and educators), I would suggest that the ideologies and practices that make it difficult to incorporate student-centered writing into the science curriculum may also tend to alienate certain groups of students (that is, white women, women and men of color, and perhaps to a lesser extent, counterculture white males) from science education and the scientific professions.

The identification of a national science personnel emergency has increased awareness of the current waste of human resources and generated projects to encourage the participation and retention in science of underrepresented groups. The impact of gender, race, and class as major categories of organization in society becomes quite clear when we look at who does science: women constitute only about 20 to 25 percent of molecular biologists; underrep-

resented racial/ethnic groups constitute perhaps 2 to 4 percent. While institutional barriers are probably the major reason for this disproportionately low participation of women and people of color, along with the general belief in science as a masculine and elitist endeavor *and* the (perhaps unconscious) prejudices by scientists against women and people of color as colleagues, I suggest that the impact of certain ideologies on the *content* of biology and molecular biology may also contribute to the exclusion of certain individuals and groups from these fields.

While difficult to prove, we must consider the possibility that these ideological problems *may* affect women and other marginalized groups in science.[5] It is quite possible that current molecular biology (and biology in general) may unknowingly promote the exclusion of politically aware women, people of color, and certain majority men as well in the following ways: by reinforcing a sexist (and, by analogy, racist) ideology of difference by empowering it with an added dimension of cellular and molecular organization of living beings; by widening the gap between science and society, and by selecting against individuals with egalitarian, antisexist, and antiracist values (these tend to be women and members of other underrepresented groups). My interviews and discussions with women, particularly feminist scientists and science and engineering students, point to the interweaving of issues of participation in science with issues of the content of science. In their experience, feminist, Afrocentric, and other radical political and ethical concerns frequently clash painfully with the practices and values of contemporary science. Thus, acknowledging and reevaluating dominant ideologies in the content of the sciences may serve to empower a more diverse cross section of science students, a necessary effort if we are to truly open science up to all segments of the population and eliminate our scientific literacy problem.

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In summary, while many scientist/educators may be uncomfortable with the discussion of explicit values and ideologies in the science classroom, there are encouraging movements afoot from several quarters to support potentially transformative science education. The introduction of nontraditional perspectives from outside the discipline holds the promise of increasing scientists' awareness of the norms of their profession, a change that is necessary if we are to attain equity within the profession and eliminate distortions in our understanding of nature.

Notes

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This talk includes portions of the published essay: "Encountering the Biological Sciences: Ideology, Language, and Learning, in Writing," *Teaching and Learning in the Disciplines*, eds., Anne Herrington and Charles Moran (New York: Routledge, 1991), 193-212.

Many of the great thinkers of Western culture, such as Aristotle, Thomas Aquinas, and St. Paul, have believed or asserted that it is in the nature of being female to be subordinate, just as it was similarly asserted that it is in the nature of slaves to serve their masters. See Agonito, Osborne.

2. This example can be found in all textbooks in molecular biology. Two of the excellent books that repeat this error are: Darnell *et al.* and Watson *et al.*

3. Specifically, Scott Gibert's studies in the history of cell biology document the association of the nucleus with the male and the cytoplasm with the female because the structure of the sperm cell is mainly a nucleus with a tail, while an egg cell has both nucleus and a large volume of cytoplasm containing other cellular organelles such as ribosomes and mitochondria. Debates in the 1930s about the relationship between nucleus and cytoplasm—cast in terms of power relations—involved metaphors of marriage and the "appropriate" relationship between husband and wife. Several different relationships were posited by the American and European scientists (all male)—domination of the nucleus over the cytoplasm, equal sharing of power and responsibility, and domination of the cytoplasm over the nucleus—each corresponding to the personal/cultural attitude and experience of the individual scientists (The Biology and Gender Study Group, Scott Gilbert, unpublished).

4. This distorted conflation is perhaps nowhere more evident than in the current multibillion-dollar project to determine the complete DNA sequence of the human genome—all the genetic material in a human. As James Watson so clearly put it, the goal of this project is "to find out what being human is" (Roberts, 167).

5. Serious science students are socialized to the dominant beliefs in the sciences and also selected for their resonance to those beliefs. Thus, the exceptional women and other underrepresented group members who enter and stay in the sciences are likely to share the dominant ideologies and values. Perceived as marginal, they may feel they have more to lose by taking a less popular stance in science

or challenging the predominant attitudes. Those who are turned away by dominant attitudes are not present among scientists to be studied.

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Feminist Critiques of Biology

Sue V. Rosser

Emphasis on biological difference between the sexes may be used to justify diverse political causes and be related to diverse theoretical roots in feminism. Minimizing biological difference in deference to social construction of gender fits a liberal political agenda. Its roots are in liberal feminism, which seeks equality and assumes objectivity and the possibility of a value-free, neutral standpoint. Not surprisingly, the feminist critiques in the 1970s and 1980s revealed androcentric bias in the evolutionary biology, sociobiology, and ecology. They used the scientific method itself to demonstrate "bad" science as biased by androcentrism; they left the notions of objectivity and the scientific method itself intact.

In contrast, the more recent writing on biological difference can be used to support either a fairly conservative or a radical political position. Emphasis upon biological difference is usually linked with essentialist feminism. Some individuals interpret essentialism as suggesting that differences between the sexes and women's inferior position in society are subject to little or no influence from social forces (a conservative political agenda). Alternatively, some feminists, particularly ecofeminists, have used biological difference to justify women's superiority to men in their connection to the earth and other species. Essentialist feminism and the emphasis on difference implicitly challenge the notions of value neutrality and objectivity. Essentialism implies that men and women would construct a different science. Challenging the notions of value neutrality and objectivity inherent in logical positivism implies accep-

tance of the social construction of knowledge, including scientific knowledge. In accepting the possibility of the social construction of scientific knowledge, feminists must still be wary of androcentric bias. In a patriarchal society in which theoretical and decision-making positions in the scientific hierarchy are held by men, the potential for androcentric bias is substantial.

Effects on Research and Questions Raised

In her recent work, *The Science Question in Feminism*, the philosopher of science Sandra Harding (1986) discusses five effects that the feminist critique has had on science.

> First of all, equity studies have documented the massive historical resistance to women's getting the education, credentials, and jobs available to similarly talented men; they have also identified the psychological and social mechanisms through which discrimination is informally maintained even when the formal barriers have been eliminated (Harding 1986, 21).

Second, the critique has revealed the use of science to support "sexist, racist, homophobic, and classist social projects." Third, the critique questions the extent to which all science must be value-laden and biased toward men's perspective, both in selection and definition of research problems and in the design and interpretation of research. Fourth, the feminist critique has used techniques from other disciplines such as psychoanalysis, literary criticism, and historical interpretation to reveal "the hidden symbolic and structural agendas of purportedly value neutral claims and practices" (Harding 1986, 23) of science. Finally, feminist

epistemologies provide an alternative understanding for what kinds of social experience "should ground the beliefs we honor as knowledge" (Harding 1986, 24).

After discussing the evidence for each of these effects, Harding concludes that the feminist critiques that point out the androcentrism, and therefore "bad science," raise a paradox. "Clearly, more scientifically rigorous and objective inquiry has produced the evidence supporting specific charges of androcentrism, but that same inquiry suggests that this kind of rigor and objectivity is androcentric" (Harding 1986, 110). This paradox in turn raises the question of the potential for a nonandrocentric or even gynocentric science.

Feminist critiques can serve as a correction for this androcentrism. The Biology and Gender Study Group (1988) expresses the potential for correction:

> We have come to look at feminist critique as we would any other experimental control. Whenever one performs an experiment, one sets up all the controls one can think of in order to make as certain as possible that the result obtained does not come from any other source. One asks oneself what assumptions one is making. Have I assumed the temperature to be constant? Have I assumed that the pH doesn't change over the time of the reaction? Feminist critiques asks if there may be some assumptions that we haven't checked concerning gender bias. In this way feminist critique should be part of normative science. Like any control, it seeks to provide critical rigor, and to ignore this critique is to ignore a possible source of error (172-73).

Effects on the Curriculum

At the same time that feminist critiques and methodologies began to evolve, other feminists in biology sought to transform the biology curriculum. The impetus for many of the first "biology of women" courses was the recognition by activists in the women's movement that women not only lacked control over their bodies but also were woefully ignorant about the functioning of their bodies. Most of the first biologically-oriented, women's studies courses were "know your body" courses that originated in an attempt to fill this knowledge gap. Since many of the teachers of these first classes were the same individuals, or at least were friends and colleagues of the people beginning feminist critiques of biology, they began to develop upper-division courses such as "gender and science" and the "history of women in science" to include these critiques.

As more evidence from research on feminist critiques and methodologies accumulated in disciplines within the humanities and social sciences, projects were undertaken to mainstream this evidence into introductory and traditional disciplinary courses. Inspired by the models for curriculum transformation developed in other disciplines, and in some cases even pushed by women's studies directors to apply those models, biologists have more recently sought to integrate feminist critiques into introductory and specialized upper-division courses in biology. The shortage of U.S. trained scientists predicted to reach epidemic proportions by the twenty-first century has forced mainstream scientists to be more open to feminist critiques and women's studies pedagogical techniques in an attempt to attract more women to biology.

Biology in Women's Studies Courses

In 1985 I published an article called "Science and Health-Related Women's Studies Courses: A Report After Ten Years in the Academy" (Rosser, 1985) in *The Feminist Teacher*. The article was based upon responses to a questionnaire sent to chairs of all 434 women's studies programs in the country at that time. The results were analyzed on the basis of 36 courses taught at 28 institutions who returned completed questionnaires, including syllabi (Rosser 1985, 32).

The results of this questionnaire gave a picture of the types of science and health-related women's studies courses that had emerged throughout the country after a decade of women's studies in the academy. Most of these courses were related to women's health and biology and were taught by faculty whose primary affiliations were with women's studies, health and/or biology departments. This finding is not surprising when one considers that two major issues of the current women's movement are women's health and reproductive rights. The influence of self-health clinics, political action, and the responsibility taken by women for learning about our bodies in collective efforts outside the academy have been extensive. These courses may represent the academy's response to the desire for knowledge in these two areas.

The second largest numbers of courses fell in the categories of the history of women in science, health and/or medicine. These courses are extremely important. They provide a fundamental basis of knowledge that we must have about ourselves before we may begin to think about more theoretical issues regarding women and science. However, the other two categories in which there was more than one course were the theories of the relationship

between women and science, and women and technology. From the syllabi and course descriptions, it is evident that these courses focus on the complex interdependence and interaction between women and science and our complicated technological society. The instructors and students explore what it is about the nature of science and technology as it is currently practiced in our Western androcentric society that excludes women at all but the most menial levels while allowing it to control us. Students and instructors begin to consider the ways in which science might be different-less hierarchical, less dualistic, less separate from human values and relationships if women could and did participate in science and technology at the controlling, decision-making levels.

Consideration of Feminism in Biology

Despite the dearth of scientists affiliated with most women's studies programs, transformation of the science curriculum has been included in the goals of most projects seeking to incorporate feminist scholarship into the curriculum.

The few scientists involved with women's studies tend to be biologists rather than physical scientists; this has resulted in biology representing the area within the physical and natural sciences in which feminist critiques are most evolved.

Phase I. Absence of Women is Not Noted. Most biology curricula are phase I. Faculty and students are not aware of the absence of women scientists in theoretical and decision-making positions in the scientific establishment, nor are they aware of the absence of women's health issues in the curriculum. They assume that since science is "objec-

tive," gender does not influence either who becomes a scientist or the science produced by those scientists. Many scientists are unaware or would openly reject the notion that gender might influence the theories, data collection, subjects chosen for experimentation, or questions asked.

Phase II. Recognition that Scientists are Male and that Science May Reflect a Masculine Perspective. Recent publicity from the federal government and various professional societies has made most scientists aware that women are underrepresented in all natural science fields, particularly in the theoretical and decision-making levels of that profession. Some scientists, influenced by scholarship in women's studies, philosophy and history of science, and psychology have begun to recognize that gender may affect science. Thomas Kuhn (1970) and his followers have suggested that all scientific theories are the products of individuals living in a particular historical and social milieu. As such, the theories are biased by the perspective and paradigms of those individuals.

Phase III. Identification of Barriers that Prevent Women from Entering Science. Acceptance of the possibility that a preponderance of male scientists may have led to the production of a science that reflects a masculine approach to the world constitutes the first step toward recognition of barriers to women becoming scientists. An aspect of this phase shows up in the current studies being made with the attempt of attracting more women into science and math, the traditionally "male" disciplines.[1]

Other evidence of the obstacles faced surfaces in article titles written by and about women in science:

"Adventures of a Woman in Science" (Weisstein 1979)

"Rosalind Franklin and DNA: A Vivid View of What It Is Like to Be a Gifted Woman in an Especially Male Profession" (Sayre 1975)

"Sex Discrimination in the Halls of Science" (Vetter 1980)

"Women in Academic Chemistry Find Rise to Full Status Difficult" (Rawls and Fox 1978)

"The Anomaly of a Woman in Physics" (Keller 1977)

"The Disadvantaged Majority: Science Education for Women" (Kahle 1983)

"Can the Difference Between Male and Female Science Majors Account for the Low Number of Women at the Doctoral Level in Science?" (Baker 1983)

"Obstacles and Constraints on Women in Science" (Matyas 1989)

"Where Are the Women in the Physical Sciences?" (Vetter 1988)

These titles suggest that women who do become scientists are frequently viewed as anomalies or face numerous problems and difficulties because of their gender.

An additional deterrent for many women and people of color is that biological research has been and continues to be used to justify social and political inequalities. Several historical and contemporary (Sayers 1982) examples exist of the use of biology to justify political and social inequities. If any inequity can be scientifically "proven" to have a biological basis, then the rationale for social pressures to erase that inequity is diminished. In both the nineteenth and twentieth centuries some scientific research has centered

on discovering the biological bases for gender differences in abilities to justify women's socially inferior position. Craniometry research and the social Darwinism quickly derived from Darwin's theory of natural selection serve as examples of the flawed science used to "prove" the inferiority of women and nonwhites (Sayers 1982).

Phase IV. Search for Women Scientists and Their Unique Contributions. The recovery of the names and contributions of the lost women of science has been invaluable research provided by historians of science who were spurred on by the work of feminists in history. Much of the work has followed the male model, focusing on the great or successful women in science.

Some historians have rejected this male model and sought to examine the lives and situations of women in science who were not famous. Margaret Rossiter's *Women Scientists in America: Struggles and Strategies to 1940* is the groundbreaking work that examines how the work of the usual woman scientist suffers from underrecognition due to application of double standards and other social barriers inherent in the structure of the scientific community.

Recovering the history of women in science often reveals the history of the use of flawed scientific research against women and people of color. Frequently, biologically deterministic theories have been used to justify women's position in society. I am defining biological determinism here as the assumption that a difference between males and females in a biological structure or hormone level at some point in development will lead to a difference in behavior, ability, or performance. The biologically deterministic theory is not new, of course. Darwin's *On the Origin of Species*, originally published in 1869, provided the framework for its current form. In 1875, Antoinette Blackwell made one of the first rebuttals of the theory using scientific infor-

mation to show that women might have different attributes and interests. During the early part of this century, many well-known women scientists (Calkins 1896; Hollingsworth 1914; Tanner 1896; and Thompson 1903) spent a great deal of time and energy pointing out scientific flaws in their search showing higher intelligence levels in males than females. Today, the biological determinism question is particularly related to two areas of current research: hormone research and animal behavior.

Today's feminist scientists refute the biologically deterministic theories by pointing out their scientific flaws (Bleier 1979; Birke, 1986; Hubbard, 1979; 1990; Lowe 1978; Rosser 1982; Fausto-Sterling 1985). These refutations and warnings about the problems of biologically deterministic assumptions are necessary. Even a century of women scientists pointing out the unscientific bases of the assumptions has not led to their eradication from current scientific theories.

Phase V. Science Done by Feminists/Women. Similarly, awareness of possible biases and flaws intro-duced into research from the dominance of males and a masculine perspective in science made faculty begin to explore unique aspects of science done by women. Three examples of recent work suggest differences in (1) distance between scientist and subject of study, (2) use of experimental subjects, and (3) language between male and female biologists.

1. In her approach towards studying maize, Barbara McClintock indicates a shortening of the distance between the observer and the object being studied and a consideration of the complex interaction between the organism and its environment. Her statements about her work suggest a closer, more intimate relationship with the subject of her research than typically is expressed by the male "objective" scientist. One does not normally associate words such as "a

feeling for the organism" (Keller 1983) with the rational, masculine approach to science. McClintock also rejects the predominant hierarchical theory of genetic DNA as the master molecule that controls gene action to focus on the control based on the interaction between the organism and its environment.

2. Models that more accurately simulate functioning, complex biological systems may be derived from using female rats as subjects in experiments. Women scientists such as Hoffman (1982) have questioned the tradition of using male rats or primates as subjects. As Hoffman (1982) points out, the rhythmic cycle of hormone secretion, as also portrayed in the cycling female rat, appears to be a more accurate model for the secretion of most hormones.

3. As more women have entered primate research, they have begun to challenge the language used to describe primate behavior and the patriarchal assumptions inherent in searches for dominance hierarchies in primates. Lancaster (1975) describes a single-male troop of animals as follows:

> For a female, males are a resource in her environment which she may use to further the survival of herself and her offspring. If environmental conditions are such that the male role can be minimal, a one-male group is likely. Only one male is necessary for a group of females if his only role is to impregnate them.

Lancaster's work points out the androcentric bias of primate behavior theories, which would describe the above group as a "harem" and consider dominance and subordination in the description of behavior. Describing the same situation using a gynocentric term such as "stud" reveals the importance of more gender-neutral language in removing bias.

Phase VI. Science Redefined and Reconstructed to Include Us All. The ultimate goal of the methods and curricular changes suggested in phases IV is the production of curriculum information and pedagogy that includes women and people of color and therefore attracts individuals from those groups to become scientists. Obviously, this curriculum and these methods have not been fully developed yet. Achievement of phase VI should accomplish more than increasing the diversity of individuals who choose to become scientists. Phase VI should also result in a better science that suffers from fewer flaws and biases. As more people from varying backgrounds and perspectives become scientists, they increase the likelihood that the scientific method will be able to function as it should. Homogeneity in gender, race, and class is what caused the scientific community to fail to include women and men of color in definition of problems for study, as experimental subjects in drug tests, and in applications of research findings.

The Introductory Course

Including new information about women and the perspective of feminism is crucial in all courses in science and health, but it is particularly crucial in introductory courses. For most students such courses serve as the introduction to college science generally and to all courses in health and biology that they will subsequently take. Traditionally, women students have not gone on in the sciences in large numbers. Women tend to exclude themselves from laboratory science because of cultural influences that dictate gender roles. Women also tend to be excluded from laboratory science by active discrimination. Even when women do choose careers in laboratory science and health care, seldom do they reach the theoretical and decision-making levels (Keller 1982).

As Fee (1982) points out, there is no feminist science yet. Feminists have only proposed methodological and theoretical changes in small areas of the biological sciences. We are at the stage of a critique of science. This critique assumes, first, that all investigations are carried out from some perspective. Decisions, either conscious or unconscious, regarding what questions are asked, who is allowed to do the asking, what information is collected, and who interprets that information create a particular vantage point from which knowledge or truth is perceived. The traditional belief in objectivity makes it difficult for scientists to admit the relevance of perspective and therefore even the more obvious perspectives by which their data and theories are influenced. Recognizing the influence of androcentrism (a recognition that has been difficult in the disciplines of the humanities and social sciences where the concept of perspective in approaching knowledge is more acceptable) is doubly difficult for the scientist. Feminist perspectives insist that women become central to the questions and theories of science and health and that women be studied for their own sake, not as compared to the male; only then does one develop accurate understanding that permits valid comparisons. With a focus on women, entirely different questions can be asked. Experiments can be set up using the female body as a model, with female rats or monkeys as the experimental subjects. Alternative and multiple interpretations of the data might be encouraged. Thus, females, the other half of humanity, would be included in the scientific descriptions of reality (Minnich 1982).

Teaching science from feminist perspectives and setting before all students the examples of great women in science and medicine should make young women realize that science is a field that is open to them. So doing will help dispel the stereotype of scientists as male. Unveiling the stories of women scientists, such as Rosalind Franklin

and Barbara McClintock, may stimulate people to do the necessary work on the history of women in science and to begin to shape a feminist science. In short, a feminist critique of science aims at making young women and men aware of the deficiencies, lack of objectivity, and androcentric bias of traditional science.

The question for the introductory biology teacher then becomes how, at the present time, can one incorporate the recent scholarship on women and science into the curriculum in a manner that will inspire further critiques and theoretical changes. How can one integrate into the standard biology curriculum the considerable but diffuse information constituting contemporary feminist perspectives: the critique of biological determinism and androcentric "objectivity," the substantial information about famous and lesser-known women scientists and their discoveries, some remarks about the obvious influence of masculine thinking on the descriptive language of biology, the feminist theoretical changes that have already taken place, and those areas where the theoretical changes are still needed?

After an introduction to the scientific method, most introductory syllabi and textbooks attempt to cover the following five broad fields within biology: the cell, genetics, development, evolution and animal behavior, and ecology. I will indicate some issues that might be raised, and some methods and activities that might aid students in understanding these issues.

1. Scientific Method. The presentation of the modern conception of the scientific method provides an ideal opportunity for presenting feminist critiques of the methodology of science that can then be applied when assessing the research and data presented in individual areas. In the feminist critiques of the scientific method, the following issues need to be raised: To what extent are the scientific

method and the theories derived from it biased by the particular social and historical context of the scientist? To what extent is the language of scientific theories reflective of a particular social and historical context? Is the scientific method really an objective approach to the world or is it androcentric? Is this androcentric bias reflected in experimental design, male subjects and models used for experimentation, and the language and conceptualization of scientific theories?

2. The Cell. The area of cell biology is one in which virtually no theoretical changes due to feminist critique have occurred. The integration of a feminist perspective in this area will probably have to be raised in terms of the language and terminology in which the theories are expressed and the very few role models of female scientists who have worked in this area.

3. Genetics. The study of genetics and DNA provides an excellent locus to raise the issues of the position of women in science and why women are not accepted as "good" scientists. Questions such as why most of the data collection and technical work are done by women while most of the theorizing and decision making are done by men in science must be addressed. Why are hypotheses suggested by women not accepted? One might also ask if the unicausal approach to teaching in genetics, which reflects a reductionist view that understanding the genes explains everything about the organism without taking into account its complex interaction with the environment (Hubbard 1990), is not a male approach to the world.

4. Development. The area of developmental biology, including endocrinology, provides opportunities to begin to raise the issues of how the male models, experimental subjects, and language used to describe those models are beginning to be transformed by a feminist critique. The

evidence that the initial ground plan for development in most species is female (Fausto-Sterling 1989) will come as a shock to most students who are used to the androcentric Western view that the male is primary in all realms and that female is the "other" or secondary (Sherfey 1975). Learning about parthenogenesis and that in development it is the so-called "reacting" (an androcentric turn of phrase?) biological system that is important in egg development rather than what is applied to it (the sperm) reemphasizes the importance of the female (Manning 1983; Biology and Gender Study Group 1989; Martin 1991).

The increasing evidence that most hormones operate on a cyclic rather than steady-state basis (Hoffman 1982) raises the question of why male rats and monkeys are used as experimental subjects when females would obviously provide a more accurate model. Students can begin to see that the "cleaner" data derived from male models due to their noncyclicity may lead scientists to oversimplified conclusions. Perhaps the "messier" data derived from female models is in fact more reflective of biological complexity. An explanation of the subtle problems that occur with biochemical conversions of hormones within the body so that an injection of testosterone may be converted to estrogen or another derivative by the time it reaches the brain (Bleier 1979) may lead students to ask questions about proper controls and extrapolating from biochemical to behavioral traits. The issue, first raised by E. E. Just in the 1930s (and now brought forth by feminist scientists) of the nature of the interaction of the cell surface with the surrounding environment demonstrates a beginning theoretical change. Standard theory holds that the cell is in a struggle with the environment; the newer theory, influenced partially by feminist critiques, suggests that cooperative processes at the cell surface may be more important (Manning 1983; Biology and Gender Study Group 1989).

5. Evolution. The field of evolution, with its subdiscipline animal behavior, provides ample opportunity for feminist critiques of the language, experimental subjects, data collection, and theoretical conclusions drawn. One may begin by questioning the extent to which Darwin's theory of natural selection was biased by the Victorian social and historical context of its time. It probably needs to be pointed out to students that the theoretical language of Darwin and his disciples (competition, struggle for existence, survival of the fittest) led to theories of biological determinism as a basis for origins of behavioral differences and abilities. These were then used to explain differences of social and economic class and as the basis for the policy of "social Darwinism" during his time (Hrdy 1981). Then, many students will be able to understand the problems of some animal behavior research, in which behavior in lower animals is observed in the framework of a search for "universal" behavior patterns in males of all species or in all males of a particular order or class, such as primates or mammals. The problems raised by then extrapolating these patterns to human beings must be addressed.

6. Ecology. Ecology is one field within biology where the traditional scientific theory and approach are most in harmony with a feminist approach to the subject. Ecology emphasizes the interrelationships among organisms, including human beings, and the earth. Feminists have also focused on the position of human beings as a part of the environmental network. Both ecology and feminism deplore the position that industrialized Western "man" has taken, that of a superior being who has dominion over and the right to exploit the earth and its other living beings, including women. The fusion of feminist and scientific theory in the field of ecology brings together the ultimate goal of the introductory course: the integration of a feminist perspective into science. It is thus the ideal subject matter on which to end the course.

Conclusion

Taken together, it becomes evident that the inclusion of feminist perspectives and methods leads to changes in models, experimental subjects, and interpretations of the data. These changes entail more inclusive, enriched theories compared to the traditional, restrictive unicausal theories. These alternative multidimensional theories generally provide a more accurate description for the introductory student to the realities of our complex biological world.

Like all scientists, biologists are forced to examine their curricula and pedagogies to make them more attractive and inclusive. Fueled by the fear and necessity engendered by a shortage of students, mainstream biologists are more willing to listen to critiques and new possibilities—including feminism. The shortage opens the possibility not only for attracting more women and people of color to science, but it also opens the possibility for changing biology. As more women and people from differing races, classes, and ethnic backgrounds become scientists, the science they evolve is likely to reflect their rich diversity of perspectives.

Note

1. The National Science Foundation (1986, 1988, 1990), Rockefeller Foundation (Berryman 1983), American Association of Colleges under the auspices of the Carnegie Corporation and the Ford Foundation (Hall and Sandler 1982), the Office of Technology Assessment (1987), and American Chemical Society (1983), along with other foundations and professional societies, have

each issued studies and reports with statistics documenting the lack of women in science and possible "causes and cures."

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Balancing the Curriculum in the Biological Sciences

Joseph N. Muzio

It was during the year-long, weekly meetings with some twenty other CUNY colleagues in the Faculty Development Seminar on "Balancing the Curriculum for Gender, Race, Ethnicity, and Class," that we discussed in an informal and open environment anywhere from five to fifteen primary source readings each week. These readings and an extensive topical outline were provided by the facilitators, and added to on occasion by the participants who also offered articles of interest. The discussions were sometimes heated, always lively, and frequently continued after the formal sessions were over.

These experiences, along with additional readings and introspection, have influenced me as the chairman and a professor in the Department of Biological Sciences at Kingsborough College. Along with several colleagues, we are reexamining our curriculum, the department's composition, and the learning experiences offered to our students. These efforts are just underway: the entire department has not yet accepted them, and it is too early to determine if they are effective in promoting changes in these areas.

There is a Latin phrase: *Res Ipsa Loquitur*. A modern version goes like this: Suppose we have an animal and we're not sure what it is. If it has feathers that shed water, walks, flies, lands on the water, has webbed feet, swims by paddling these webbed feet, and makes the sounds of "quack, quack, quack," then we have every reason to believe that it must be a *duck*! In the translation of the Latin, "The thing speaks for itself."

Regarding balancing the curriculum for gender, race, ethnicity, and class, it is my view that these things speak for themselves, too. In relation to scholarship, curriculum development, and teaching/learning strategies in the biological sciences, there have not been dramatic changes in the past twenty years. And unless there are far more profound and concerted efforts, especially in faculty development programs, and in consciousness-raising efforts among female and male faculty members, there may not be much change in another twenty years.

Despite a frequently held view among some segments of the public that faculty members are quite innovative and receptive to change, there are powerful forces resistant to changes in scholarship, curriculum, and teaching/learning strategies. Many faculty are extremely conservative in modifying curriculum, or in changing their approaches. Special interests are partially responsible for such resistance to changes. The desire to maintain clearly defined academic disciplines or departments and, thus, spheres of influence within the academic institution, and the faculty's comfort in keeping the curriculum and courses the way they are constitute examples of these special interests.

Certainly, in recent years, there have been some curriculum changes affecting women and the sciences, but it is sometimes difficult to distinguish between the appearance and the substance of change. As Sue V. Rosser notes in *Feminist Approaches to Science*, "There are thousands of women's studies courses, hundreds of women's centers, and thousands more women achieving their doctorates in the sciences and engineering" (p. 165). Despite these seemingly important changes, Rosser reminds us:

> The teaching of science in most institutions has been affected very little by the feminist transformation

> . . . The "factual" nature of most science courses leads instructors to emphasize information derived from experiments. Few instructors consider for themselves, and fewer still attempt to convey to the students, the parameters of social, historical, and gender bias that may influence the theories derived from interpretation of the facts. Many professors think that gender is not a bias that influences hypotheses, subjects, experimental design or theory formation in science; therefore the absence of women is not noted (p. 169).

Let me return to *Res Ipsa Loquitur*. I will describe some information gathered after teaching the "Biology of Women" course over three semesters. I approach the course from a feminist perspective, and each semester I have made changes. I will briefly identify the efforts made in this course and in our Biological Sciences Department: some activities are related to curricula, language, and readings, and others to scholarship. The CUNY faculty seminar I attended allowed me to explore with these colleagues their views on a draft outline for the course, and their responses have had a major influence on my thinking about departmental curriculum and staff activities.

At the start of each semester, the students in the "Biology of Women" course, mostly women, are asked to write a brief description of an experience they have had in the health-care system. The prime purpose of this initial writing exercise is for the students to describe a topic involving their bodies/minds when they used any aspect of our nation's vast health services. Suggested situations include: an emergency; a physical examination; an illness; a visit to a physician or dentist; interaction with a nurse; experience in a hospital or other health-care facility. If the student prefers, she/he can focus on the experience of a relative or friend, provided it is not hearsay.

The assumption is that by focusing on such personal experiences/situations, excellent anecdotal information will be provided as to how the students perceive their relationships within the health professions and the concomitant institutional settings. The object is to encourage them to begin to analyze the ways they are treated in those vital areas relevant to the biology of their bodies, in health and/or illness. Almost 150 student responses have been gathered over three semesters. Our college students are urban, made up mostly of minorities, and frequently use public health-care facilities and sources. There are occasional examples of positive responses by female or male students, but the negative responses are overwhelming. Again and again, students recount alleged sexual harassment; insensitive and inappropriate remarks and behaviors; questionable practices; and rudeness and incivility by practitioners or employees in the health-care institutions.

A few examples of female students' more memorable statements are: suggestive comments made about their breasts or buttocks; being left in the stirrups for long periods of time during gynecological examinations; told that "they look good down there;" questionable manipulations of their bodies for seemingly excessive periods of time; sometimes, and without permission, being examined by a group of physicians, usually all males; crude jokes made about women's bodies and/or their minds; being told they wouldn't understand the medical terms being used about their bodies; and the ultimate insults, that they were being "emotional," "silly," "hypochondriacal," "childish," or "acting like a woman."

If these students' statements are accurate, their repetitiveness reflects pervasive, denigrating, and insensitive attitudes and behaviors regarding women, their bodies, and their bodily functions. Keep in mind that these reported

remarks and behaviors are from professional and highly trained individuals. Those who serve and assist others during times of need, anxiety, and vulnerability. One can only wonder whether such remarks and behaviors are isolated, or more reflective of those across our society. And, some of the more negative remarks the students reported were made not by men, but by women practitioners, or women in the health-care system. There is no assurance women practitioners exhibit greater sensitivity and concern for women using their professional/technical services (at least those in this student population). Perhaps it is because the women practitioners have been trained at male-dominated learning institutions, where they have taken on prevailing male traits in order to function successfully.

Once I have read the students' papers, commented upon and returned them, the class discusses some of the highlights from these papers, their authors remaining anonymous. We consider alternative approaches to these representative situations and use them as case studies. Reviewing these situations together reassures the predominantly female student population that such experiences occur to others, opening up such topics early in the semester.

Later in the semester, after studying more of the course, students confirm a new sense of empowerment. They mention how much more knowledgeable they are about their bodies, and how skeptical they are becoming when they use our health-care industries. Many describe new behaviors and attitudes more demonstrative of competency and self-assuredness in health-care situations.

At the end of the semester in this course, I ask the students to respond to the following question on their final examination. (Obviously, there is no right or wrong answer). Once again, the goal is to have the students reflect on our many activities in this course:

> You have just completed a one-semester course in the "Biology of Women," where efforts were made to examine this topic through a feminist perspective. Describe how this course and its related experiences have influenced your thinking, feelings and actions on the topics we considered. Furthermore, do you have any suggestions or comments to make regarding how this course can be improved for future students, as well as how the instructor can improve?

In their responses, students often provide further examples of their new-found knowledge and empowerment. They explain how the topics and discussions considered in the "Biology of Women" course have enabled them to be far more articulate about themselves: they give reasons why they are more comfortable about their biological processes; they record a new willingness to ask health-care practitioners questions, so they can be better informed about what is being done to their bodies; they are more outspoken regarding their perceptions of sexual harassment and inappropriate comments and jokes about women's biology; and most important of all, they have begun to see themselves in different ways, not simply as passive objects silently allowing their bodies to be clinicized, treated, or made fun of. Also, the students comment often about their individual responsibility to their health and their desire to be more involved in their wellness and the avoidance of illness.

Part of this sense of taking charge occurred as students in the "Biology of Women" course began to engage in an exchange of current information about health issues. I regularly gave them articles from journals and the *Science Times* on topics related to the biology of women, some thirty-six articles on diverse topics in the past semester. The students then began providing articles for the class,

which were duplicated and distributed. Both the students and I undertook to inform the class about relevant television and radio programs that could help us on biology of women topics.

Part of my efforts in this course have been to modify verbal and written language use, especially with regard to gender and the biological sciences. These daily efforts are well in advance of most language usage in biological sciences textbooks, which are slow to respond to such matters. One example is in reference to the term "menstrual cycle." To focus solely on the menstrual portion of diverse anatomical and physiological activities taking place before, during and after ovulation is misleading. A much more appropriate term is the "ovulatory-menstrual cycle," because this more accurately identifies the entire developmental process and the interrelatedness of the neuro-endocrine systems, the ovaries, uterus, and the entire body.

A further example is related to the biological process of fertilization. Most instructors and textbooks focus on the male sperm penetrating the ovum after the male has penetrated the female body. A more bonafide focus is upon the mutuality of events leading up to and promoting fertilization. There is, similarly, a need to emphasize the significance of maternal inheritance, that is those biological contributions made exclusively by the ovum. The sperm contributes chromosomes, while the ovum provides chromosomes, mitochondria, and other vital biological structures and materials for successful embryonic development. Isn't it paradoxical that even though the ovum contributes considerably more to fertilization and subsequent concomitant events, most textbooks and faculty focus on the *equality* of the chromosomal number of the sperm and the ovum. We might at least raise the question, Why is this?

In this course, myths regarding male and female anatomy and physiology, male superiority, male strength, male dominance, and gender identity are dealt with in a forthright and clarifying manner. Anne Fausto-Sterling (1985), writing about such myths, has been especially helpful here. Other issues considered in the "Biology of Women" course are: How are women and their bodies studied? Why are research data about women usually derived from male studies? Why are virtually all contraceptive devices designed for women's bodies (the condom is *not* just a contraceptive device, it is perhaps a life-saving mechanism)? Why are there so many products for women's bodies? Why are there so many hysterectomies, mastectomies, and Caesarian deliveries? Why are there so many inconclusive studies and data about mammography? Why are women and their biological processes so often clinicized and treated as syndromes (Wolfe 1991)? These and other topics are predicated on specific biological concepts, but they are examined within a biosocial context. Early in the semester, students find this biosocial approach somewhat off-putting, because they expect and want topics to be concrete and defined purely in scientific fact. Later in the semester they are willing to take part in these discussions.

Other efforts are underway in our department to promote greater sensitivity to feminist perspectives. This translates into some of us seeking approaches less reliant on the traditional, male-focus knowledge in the biological sciences. I will end my remarks with a description of some of these activities.

1. As already noted, there is no guarantee that women academics will of necessity, behave, teach, and explore other learning modalities that might be more supportive to women from a feminist perspective. But because there are so few women faculty members in the biological sciences,

our department has made a concerted effort to seek and hire women faculty, especially those of minority races and ethnicity. Several new women faculty have recently joined our department, all of them well-qualified. They have brought different perspectives to the classroom, curriculum developments, department meetings, and to our college. This effort needs to be continued to offset long-standing professional employment inequities for women. One cannot help but believe that the presence of women faculty members will influence many of our female minority students in positive ways regarding their thoughts about their future education and career options, and about themselves as women.

2. Students in our department have access to a recently prepared college brochure, "Sexual Harassment," a matter of frequent concern to women. In the "Biology of Women" course, I handed out this brochure and a recently published "Women's Resource Manual" prepared by our college's women's center to each student and discussed them in class early in the semester. These documents provide information and enlightenment to our students about programs, services, and opportunities regarding women.

With regard to the issue of sexual harassment, I would like to make a few additional remarks. By no means should one assume that because so many students in the "Biology of Women" course reported sexual harassment incidents, all health-care practitioners engage in such practices. Or, that sexual harassment occurs exclusively in the health-care fields. Sexual harassment of women occurs at every level of our society. Perhaps it should be viewed as endemic. Even female doctors are victims of sexual harassment! In a recent survey 75 percent of the responding female doctors (410 of 599 respondents, with 1064 women doctors mailed the questionnaires) reported sexual harass-

ment by *their patients* (New York Times, December 23, 1993). Sexual harassment of women and its consequences are major obstructions to women's development, their education, career choices, and leadership positions. Females *and* males need enlightened educational experiences and sensitization on these topics if we are going to have a marked reduction in such denigration of women. In addition, there is a need for intense research as to the possible interconnectedness between sexual harassment of women and other violent psychosexual acts toward them: rape, incest, physical abuse, and pornography. Research into these matters might also shed some light on family relationships, childrearing, education practices, and other dynamics regarding gender, race, ethnicity, and class.

Incidentally, another area that could help to clarify female/male relationships is related to sexual harassment of males. While there have been some recent cases of such harassment reported, accurate data as to the frequency and most circumstances are lacking. Do most males in our society even conceptualize being sexually harassed? Can males conceptualize heterosexual rape?

3. Female and male faculty members are encouraged to seek out examples of positive, female, culturally diverse examples of scientists to cite in classes and in laboratory situations. It must be noted that textbooks for the most part are noticeably weak in these realms. They seldom present women, certainly not those of color and/or diversity. On this issue of textbook biases, some of us have taken it upon ourselves to speak with college textbook editors. We have encouraged the editors to begin to address these gender and ethnicity inequities.

4. As chair, I have distributed to the members of the Biological Sciences Department copies of articles related to gender, race, ethnicity, and class. Some came from the

Faculty Development Seminar; others are from my growing collection of such references, focusing on the biological sciences. The obvious goal is to aid colleagues to become acquainted with this relatively recent body of literature with the hope that if read, this information will influence faculty and will result in future curriculum revisions more sensitive to these issues.

5. More textbooks and references in the biological sciences, each with a greater emphasis on feminist perspectives, have been requested and placed in the library. Most of them are being used in the "Biology of Women" and "Genetics" courses, and sometimes in the "Human Anatomy and Physiology" courses. Faculty have noticed these references appearing more frequently in the students' term papers and in their reaction papers.

These efforts and many more will be necessary in order to promote changes making the curriculum, scholarship, and teaching/learning strategies more responsive to the issues of gender, race, ethnicity, and class. Persistent, long-term efforts are required and must be likened to those still underway in our country's civil rights and environmental movements. After all, we are talking about long-established habits and behaviors related to power, control, money, competition, and the cultural subjugation of others.

Almost exclusively European male concepts dominate curriculum development and the pursuit of scholarship in our society. Such dominating ideas, values, behaviors, and institutions do not fade away easily. As Bronowski (1973) reminds us, however, there are always "turning points." It is difficult to assess whether these sorely needed curriculum revisions and behavioral modifications will occur until we reach such a turning point.

Our present educational configurations are not especially effective or successful. The question now is, will we have the resources, courage, political will and, above all, the integrity to see through curriculum development and learning/teaching strategies in totally new formats that create inclusion of gender, race, ethnicity, and class? No society can really afford the incredibly wasteful luxury of excluding any aspect of that society as it addresses chronically complex and changing problems. It would be sheer madness for our society—committed to the goals of democracy —to persist in treating *any* portion of its population shabbily, insensitively, and unequally.

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[This document is a synthesis of the talk delivered April 26, 1993, with subsequent reflections on the subject.]

Women in Science and Engineering

Edward B. Tucker

The data that I will present clearly indicate that: (1) women are a significant part of the contemporary scientific community, (2) the proportion of scientists that are women has increased over the past decade, and (3) there is every reason to believe that this trend will continue in the future. One wonders if a change in the science curriculum is at least partially responsible for this increase of women in science. To initiate some thought on this topic, I will describe the curriculum from one CUNY Senior College that biology majors take today and compare it with the curriculum that their predecessors took a decade ago. I am a 1992 graduate of the CUNY Faculty Seminar on "Balancing the Curriculum for Gender, Race, Ethnicity, and Class." During one of our meetings we examined passages from several introductory biology textbooks for gender bias, and I will share that with you.

The data on the numbers of women in science was obtained from Mary E. Clutter, Assistant Director, Biological Sciences, the National Science Foundation, Washington, D.C. Dr. Clutter had occasion to present this information to science faculty at the State University of North Carolina in Raleigh. The percentage of women in the various fields was calculated by dividing the number of women in the field by the number of men and women in that field. Proportional change was calculated by dividing the number of women in a field in 1990 by the number of women in that field in 1980. A proportional value of 1.0 means no change, while a number greater than 1.0 indicates a pro-

portional increase. The Hunter College Biology major curricula were obtained from the 1980 and 1993 undergraduate catalogs, and information on the number and gender of faculty members was obtained from Dr. Shirley Rapps, chairperson of Biology.

A. Women in Science and Engineering: 1980 to 1990

In 1988, 867,900 women were employed as scientists and engineers in the United States. In 1989, 39,884 women were in professorial positions in science and engineering at colleges and universities. In 1991, 9,023 women were awarded Ph.D.s in science and engineering. And, in 1989, 70 percent of the students who graduated with a bachelors degree in psychology were women; 45 percent in life sciences and social sciences were women; 35 percent in mathematics/computer science and physical sciences were women; 26 percent in earth science were women, and 16 percent in engineering were women.

The number of women choosing careers in science and engineering has increased over the past 10 years (see Table 1). In 1978, 9.3 percent of those employed in science and engineering were women, compared to the 16 percent in 1988. While the total number of men increased 1.9 times over this ten-year period, the total number of women increased 3.6 times. The largest proportional increase was in computer science (5.4 percent) and engineering (4.2 percent), while the smallest proportional increase was in environmental sciences (1.7 percent). The large proportional increase in computer science is not a surprise. This field is relatively new; it has many job and financial opportunities; and it does not have a reputation of being a male occupation. On the other hand, the large proportional

change in engineering, which does have a reputation as being a male field, is surprising. The small proportional change in the environmental sciences is disappointing, for this field will become a very important one.

The percentage of women in the professorial ranks at colleges and universities also increased in all areas of science and engineering between 1979 and 1989 (see Table 2). In 1979, women made up 20.5 percent of assistant professors, 10.8 percent of associate professors and 5.1 percent of professors as compared to 29.3 percent of assistant professors, 19.1 percent of associate professors and 8.2 percent of full professors in 1989. While the total number of positions from 1979 to 1989 increased 1.8 times, the number of women filling these positions increased 2.9 times. The greatest proportional increase was in computer science (8.0 percent) and engineering (6.7 percent), while the smallest proportional increase was in mathematics (1.7 percent). The number of women associate professors increased between 1.8 and 6.9 percent in engineering, social sciences, physical science, environmental science, and mathematics; and 10.6 percent and 11.3 percent in psychology and life sciences. In all fields the proportional increase of associate and full professors was larger for women than for the total (men and women).

It is clear that in 1979 there were more male professors than male associate professors and more male associate professors than male assistant professors (see Table 2). Men advanced into and remained in the ranks of associate and full professorship. However, for women the situation in 1979 was just the opposite as there were fewer women professors than woman associate professors and fewer women associate professors than women assistant professors. This trend of retention of men and attrition for women remained the same in 1989. It appears that many of the

women hired as assistant professors in the early eighties were not tenured and thus did not move up the ranks. Some women may have left academia because they chose to; others left because they were forced to. If a woman wants to raise children, there are no mechanisms in place at colleges and universities to allow for a break in research productivity, or to assist a woman so that she can readily do both. In most academic institutions, the quantity of publications and procurement of grants is the major criteria for tenure and promotion.

The percentage of women awarded a Ph.D. in science and engineering also rose between 1980 and 1991 (see Table 3). In 1980, women were awarded 1,311 Ph.D.s in psychology; 1,150 in agriculture; and 1,053 in biology; and those numbers rose to 1,984; 1,968; and 1,759 in 1991. Ph.D.s awarded to women in the physical sciences, engineering, and chemistry were 322, 90, and 255 for women in 1980 and rose to 659, 452, and 507 in 1991. Ph.D.s awarded to women in computer science, earth science, and mathematics were 21, 64, and 95, and rose to 116, 185, and 194 in 1991. While the total number of Ph.D.s awarded increased 1.4 times, the proportion awarded to women increased 1.7 times. The largest proportional increase occurred in the fields of computer science (5.5 percent) and engineering (5.0 percent), while the smallest proportional increase occurred in social science (1.4 percent), psychology (1.5 percent), agriculture (1.2 percent) and biological sciences (1.2 percent).

The percentage of women students awarded bachelor degrees in science and engineering also increased over the past twenty years (see Table 4). The largest increase was noted in the areas of psychology where 71 percent of the class of 1989 were women compared to 42 percent in 1966. The smallest increase was in the fields of mathematics

and computer science where the number rose from 33 percent to 36 percent.

B. Biological Sciences Curriculum

A careful and thorough study of the science curriculum should be made to determine what changes have taken place over the past ten years. Results might indicate that specific changes are partially responsible for the noted increase of women in science. As a preliminary step, we can compare the 1993 Hunter College biology curriculum with that of the 1980 curriculum. I have chosen Hunter College's biology curriculum because it is a CUNY curriculum and because graduates of this program are excellent scientists. The biology major listed in the 1980 catalogue was designed for students who intended to prepare for advanced study, secondary school teaching, or careers in biology, medicine, and dentistry. The plan consisted of 26 credits including a 16-credit central core of required courses and 10 credits of electives. The biology major listed in the 1993 catalog was designed for students who intend to prepare for graduate study, medicine, dentistry, secondary school teaching, biotechnology, and industry. The plan consists of 27.5 credits, including a 17.5 credit core of required courses and 10 credits of electives.

The structure of the biology curriculum has changed very little over the past ten years (see Table 5). However, the content has changed; there are now more course offerings in the fields of molecular biology and molecular genetics. The department now houses the Institute for Biomolecular Structure and Function, and the curriculum emphasizes cell biology, molecular biology, and genetics as the foundations for future careers in science. This emphasis on molecular biology reflects what is occurring in science both nationally and internationally. Most of us here would

not recognize a modern cell biology course, because the material comes from the recent explosion of information on gene regulation. Little time is spent on cell structure and function. There have also been changes in the biology faculty at Hunter College. In 1980, the faculty consisted of 6 male professors, 5 female professors; 7 male associate professors, 11 female associate professors; 2 male assistant professors, and no female assistant professors. Women represented 30 percent of the biology faculty. Today (1993) the department is composed of 7 male professors, 5 female professors; 4 male associate professors, 2 female associate professors; and no assistant professors. Women make up 40 percent of the faculty. The increased percentage of women in professorial ranks reflects the national trend, but the 40 percent ratio does not reflect the national ratio, which is 24 percent.

C. Language Used in Textbooks

Critical research needs to be done to determine: (1) if gender bias is present in our science textbooks, (2) whether the language discourages women from science, and (3) whether this biased language is being removed in subsequent editions. As a very preliminary introduction, we examined passages from two introductory textbooks. The passage regarding "sex determination" in four editions of William T. Keeton's *Biological Science* is cited below. The copyright dates are 1967, 1976, 1980, and 1986. This same statement appears in all four editions.

> When fertilization takes place, the chances are approximately equal that the egg will be fertilized by a sperm carrying an X chromosome or by a sperm carrying a Y chromosome. If fertilization is by an X-bearing sperm, the resulting zygote will be XX and will develop into a female. If fertilization is by a Y-bearing sperm, the re-

> sulting zygote will by XY and will develop into a male. We see, therefore, that the sex of an individual is normally determined at the moment of fertilization and depends upon which of the two types of sperm fertilizes the egg.

For a comparison, here are two passages from John H. Postlewait and Janet L. Hopson's *The Nature of Life* (1992):

> The fusion of egg and sperm is called fertilization, and results in a single cell, the zygote, in which hereditary information from both parents unites and creates a new combination that is genetically unique (p. 154).

> If an X and Y segregate in meiosis, then half the sperm will contain a Y and the other half an X chromosome. If these sperm randomly fertilize a group of eggs, each egg containing an X chromosome, then half of the zygotes formed will be male and half female. Note that a male's single X chromosome has to come from his mother. Abraham Lincoln once said, "All I am and have I owe to my mother." This certainly was true for the characteristics related to his X chromosome (p. 176).

While the majority of science faculty I interviewed believe there is no gender bias in the passage from *Biological Science*, many undergraduate students in my "Introductory Biology" courses believe there is. These students suggest that the sperm has been given the controlling role of fertilizing the egg and of determining the sex of the zygote. Students do not find as much gender bias in the passages from *The Nature of Life*.

Conclusion

Women choose some fields of science and not others. The data illustrate that more women attained Ph.D. degrees and academic positions in life science and psychology, and fewer in earth science, environmental science, mathematics and engineering (see Tables 2 and 3). While it appears that at present few women have advanced degrees or academic positions in computer science, a large percentage of computer science professionals in the United States are women (see Tables 3, 2, and 1). In the future we are likely to see the greatest change in the fields of computer science and engineering because the greatest proportional changes are taking place in these fields (see Table 1).

The number of women in science and engineering has increased over the past ten years. Since the number of women graduating and attaining Ph.D. degrees in the sciences is increasing, the number of women in science will continue to increase. We need to ask: What is it about mathematics and environmental sciences that many women dislike? What is happening in engineering that many women are finding attractive? Will there be curricular changes in computer science and engineering that encourage or do not discourage women from these fields? Probably the most effective way to increase the number of women in science is to decrease the number who leave.

Field	1978	Percent	1988	Percent
Science and Engineering,				
Total	2,609,800		5,286,400	
Female	242,200	9.3	867,900	16.4
Science,				
Total	1,071,000		1,567,800	
Female	213,400	19.9	745,700	47.6
Physical Science,				
Total	208,300		312,000	
Female	18,500	8.9	46,500	14.9
Mathematics,				
Total	53,700		168,600	
Female	13,100	24.4	44,900	26.6
Computer Science,				
Total	177,000		708,300	
Female	40,200	22.7	218,700	30.9
Environmental Science,				
Total	68,900		113,400	
Female	7,200	10.4	12,300	10.8
Life Science,				
Total	244,100		458,600	
Female	39,600	16.2	127,800	27.9
Psychology,				
Total	121,700		275,900	
Female	42,000	34.5	132,000	47.8
Social Science,				
Total	97,400		531,000	
Female	52,800	26.7	163,700	30.8
Engineers,				
Total	1,538,800		2,718,600	
Female	28,800	1.9	22,200	4.5

Table 1:
Employed Scientists and Engineers by Field and Gender: 1978, 1988

Field/Sex		Professor	%	Associate Professor	%	Assistant Professor	%
All:	1979	50,367		35,588		5,910	
	Female	2,576	5.1	3,857	10.8	28,789	20.5
	1989	90,205		50,550		38,687	
	Female	7,348	8.2	9,677	19.1	11,316	29.3
Physical:	1979	9,147		5,241		3,022	
	Female	263	2.9	262	10.8	330	10.9
	1989	13,049		4,302		3,276	
	Female	552	4.2	421	19.1	502	15.3
Math:	1979	4,435		3,673		2,370	
	Female	181	4.1	217	5.0	311	13.1
	1989	6,822		3,267		2,513	
	Female	343	5.0	420	9.8	444	17.7
Computer:	1979	460		449		655	
	Female	7	1.5	27	5.9	47	7.2
	1989	1,606		1,884		1,726	
	Female	85	5.3	165	12.9	233	13.5
Environment:							
	1979	1,724		1,112		819	
	Female	38	2.2	35	6.0	84	10.3
	1989	3,160		1,625		1,240	
	Female	100	3.2	139	8.8	258	20.9
Life:	1979	12,026		9,202		8,006	
	Female	834	6.9	1,187	3.2	1,856	23.2
	1989	24,877		14,994		12,772	
	Female	2,590	10.4	3,633	8.6	4,579	35.9
Psychology:							
	1979	5,098		3,840		3,729	
	Female	477	9.4	758	12.9	1,324	35.5
	1989	8,958		5,689		4,431	
	Female	1,542	17.2	1,723	24.2	2,088	47.1
Social:	1979	11,300		8,383		8,481	
	Female	761	6.7	1,344	19.7	1,900	22.4
	1989	20,405		13,611	30.3	8,743	
	Female	2,048	10.0	3,043		2,921	33.4
Engineers:	1979	6,177		3,688		1,707	
	Female	15	0.2	27	16.0	58	3.4
	1989	11,328		5,178		3,986	
	Female	90	0.8	133	22.4	290	7.3

Table 2:
Science and Engineering at Colleges/Universities by Field, Sex, Academic Rank: 1979, 1989

	1970	1980	%	1985	1991	%
S&E	18,044	17,523		18,712	23,748	
Sciences	14,598	15,044		15,546	18,536	
FEMALE						
S&E	1,644	3,884	22.2	4,812	6,757	28.5
Sciences	1,628	3,794	25.2	4,614	6,305	34.0
Phy Sci	227	322	12.8	464	659	18.3
M&F	3,893	2,521		2,916	3,602	
Chemistry	182	255	16.6	362	507	23.1
M&F	2,238	1,538		1,836	2,194	
Earth	15	64	10.2	111	185	22.1
M&F	498	628		617	837	
Math	77	95	12.8	106	194	18.7
M&F	1,225	744		688	1,040	
Comp Sci	--	21	9.6	33	116	14.6
M&F	--	218		310	797	
Agric	538	1,150	24.4	1,409	1,968	34.4
M&F	4,165	4,715		4,904	5,714	
Bio	515	1,053	27.7	1,238	1,759	37.9
M&F	3,361	3,803		3,793	4,642	
Soc Sci	327	831	22.6	950	1,199	36.3
M&F	2,927	3,120		2,994	3,306	
Psy	444	1,311	42.3	1,541	1,984	61.2
M&F	1,890	3,098		3,117	3,240	
Eng	16	90	3.6	198	452	8.7
M&F	3,446	2,479		3,166	5,212	

Table 3:
Science and Engineering Ph.D.s Awarded by Sex and Field: 1970, 1980, 1985, 1991

DEGREE	1966 Percent Women	1989 Percent Women
Engineering	1%	16%
Physical Sciences	14%	32%
Earth Sciences	9%	26%
Math/Computer Science	33%	36%
Biology/Agriculture	23%	46%
Social Science	33%	45%
Psychology	42%	71%

Table 4:
Bachelor's Degrees Awarded to Women, by Field: 1966 and 1989

1980	1993
PREREQUISITES Two semesters General Chemistry Two semesters Organic Chemistry Two semesters Physics Two semesters Calculus	**PREREQUISITES** Two semesters General Chemistry Two semesters Organic Chemistry Two semesters Physics Two semesters Calculus and Geometry
Introductory Biology I and II	Introductory Biology I and II
CORE (16 credits) B204 Cell Biology B300 Molecular Biology B320 General B332 Cell Physiology French or German (if intended Ph.D.)	**CORE** (17.5 credits) B200 Cell Biology Microorganisms B202 Cell Biology Eukary B300 Molecular Biology B302 Molecular General
ELECTIVES (10 credits) Developmental Biology Evolution Comparative Animal Physiology Plant Physiology Laboratory in Fine Structure Special Topics in Biology Introduction to Research	**ELECTIVES** (10 credits) Developmental Biology Evolution Comparative Animal Physiology Plant Physiology Laboratory of Fine Structure Special Topics in Biology Introduction to Research Environmental Microbiology Regulation of Cell Proliferation Molecular Immunology Physiology of Nervous System Endocrinology

Table 5:
Curriculum Leading to a Bachelor's Degree (Major I) at Hunter College: 1980, 1993

CONTRIBUTORS

Note: These biographical notes were current as of 1993 when these essays were first published.

DOROTHY O. HELLY is Professor of History and Women's Studies at Hunter College. She has worked with CUNY curriculum transformation projects since 1983 and cofacilitates the CUNY Faculty Seminar in Balancing the Curriculum for Gender, Race, Ethnicity, and Class. She began the Academy Seminar in 1988–89 to provide a general forum for these issues. She is author of *Livingstone's Legacy: Horace Waller and Victorian Mythmaking*, coauthor of *Women's Realities, Women's Choices: An Introduction to Women's Studies*, and coeditor of *Gendered Domains: Rethinking Public and Private in Women's History*.

JOSEPH N. MUZIO is Professor and Chair of the Department of Biological Sciences at Kingsborough Community College at the City University of New York. He earned a B.A. from Queens College, an M.A. and Ed.D. from Teachers College, Columbia University. He has done Sleep Research at both Mount Sinai Hospital and Columbia Presbyterian Hospital and has held a National Marine Fisheries Service Grant for a curriculum development and training program. He has written a textbook on *Human Anatomy and Physiology, a Complete Self-Study Program*

and many papers on sleep research and science instruction, including "Human Anatomy and Physiology: Who Really Develops the Curriculum?"

SUE V. ROSSER is Professor of Family and Preventive Medicine and Director of Women's Studies at the University of South Carolina-Columbia. She received her Ph.D. from the University of Wisconsin-Madison in zoology. Author of a great number of journal articles on the theoretical and applied problems of women and science and women's health, she has also written *Teaching About Science and Health from a Feminist Perspective: A Practical Guide; Feminism Within the Science and Health Care Professions: Overcoming Resistence; Female-Friendly Science*; and *Feminism and Biology: A Dynamic Interaction*. She is currently at work on a book to be entitled *People Friendly Medicine* and is Latin and North American coeditor of *Women's Studies International Forum*. The National Science Foundation awarded her a $119,000 grant for the Transformation of Science and Math teaching to Reach Women in Varied Campus Settings at the University of South Carolina.

BONNIE B. SPANIER is Associate Professor and Chair of the Women's Studies Department, State University of New York at Albany. She earned her B.A. at Bryn Mawr College in Biology and her M.A. in Biochemistry and Ph.D. in Microbiology and Molecular Genetics at Harvard University. She was awarded the SUNY Chancellor's Award for Excellence in Teaching in 1992. Her articles and book chapters range widely from "Newcastle Disease Virus Protein Synthesis" to "Transforming the College Biology Curriculum: Themes, Strategies, and Resources." She has

co-edited *Toward a Balanced Curriculum: A Sourcebook for Initiating Integration Projects Based on the Wheaton College Conference* and has written *Gender and Ideology in Science: Molecular Biology from a Feminist Perspective*. Her current work includes *Making a Difference: Eliminating Gender and Related Biases in the Content of Science* and "Science and Feminism: Resistance to Gender Ideology Among Women Scientists."

EDWARD B. TUCKER is an Associate Professor of Natural Sciences at Baruch College and a member of the Doctoral Faculty of the City University of New York Graduate Center in Biology. He earned his Ph.D. at the University of Calgary in Plant Physiology, did postdoctoral fellowships at that university and at Harvard Medical School, was a research associate at Cornell University and the Marine Biological Laboratory, was a visiting professor in the People's Republic of China, and has taught at the New York Botanical Garden. Among his many publications are two book chapters on "dye-coupling between plant cells" and how "inositol phosphates diacylglcerols inhibit cell-to-cell transport." Recent papers involve cell-to-cell diffusion and cell-to-cell selectivity in staminal hairs of *Setcreasea purpurea*. He has presented his work at the University of York in England and at Purdue University and is a reviewer for the National Science Foundation and U.S. Department of Agriculture.

Reader Comment

Rethinking the Disciplines: Biology

Thank you for taking a few minutes to provide us with your response to this group of essays. If you have shared it with others, please feel free to copy this form and provide it to them.

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Publications of the National Center for Curriculum Transformation Resources on Women

WOMEN IN THE CURRICULUM

The following publications consist of directories, manuals, and essays covering the primary information needed by educators to transform the curriculum to incorporate the scholarship on women. The publications have been designed to be brief, user friendly, and cross referenced to each other. They can be purchased as a set or as individual titles. Tables of contents and sample passages are available on the National Center Web page: http://www.towson.edu/ncctrw/.

➢ ***Directory of Curriculum Transformation Projects and Activities in the U.S.***

The *Directory* provides brief descriptions of 237 curriculum transformation projects or activities from 1973 to the present. It is intended to help educators review the amount and kinds of work that have been occurring in curriculum transformation on women and encourage them to consult project publications (see also *Catalog of Resources*) and to contact project directors for more information about projects of particular interest and relevance to their needs.

386 pages, 8½ X 11 hardcover, $30 individuals, $45 institutions, ISBN 1-885303-07-6

➢ ***Catalog of Curriculum Transformation Resources***

The *Catalog* lists materials developed by curriculum transformation projects and national organizations that are available either free or for sale. These include proposals, reports, bibliographies, workshop descriptions, reading lists, revised syllabi, classroom materials, participant essays, newsletters, and other products of curriculum transformation activities, especially from those projects listed in the *Directory*. These resources provide valuable information, models, and examples for educators leading and participating in curriculum transformation activities.

(Available fall 1997)

➢ ***Introductory Bibliography for Curriculum Transformation***

The *Introductory Bibliography* provides a list of references for beginning curriculum transformation on women, especially for those organizing projects and activities for faculty and teachers. It does not attempt to be comprehensive but rather to simplify the process of selection by offering an "introduction" that will lead you to other sources.

15 pages, 6 x 9 paper, $7, ISBN 1-885303-32-7

➢ ***Getting Started: Planning Curriculum Transformation***

Planning Curriculum Transformation describes the major stages and components of curriculum transformation projects as they have developed since about 1980. Written by Elaine Hedges, whose long experience in women's studies and curriculum transformation projects informs this synthesis, *Getting Started* is designed to help faculty and administrators initiate, plan, and conduct faculty development and curriculum projects whose purpose is to incorporate the content and perspectives of women's studies and race/ethnic studies scholarship into their courses.

124 pages, 6 x 9 hardcover, $20 individuals, $30 institutions, ISBN 1-885303-06-8

➢ ***Internet Resources on Women: Using Electronic Media in Curriculum Transformation***

This manual gives clear, step-by-step instructions on how to use e-mail, find e-mail addresses, and access e-mail discussion lists relevant to curriculum transformation. It explains Telnet, FTP, Gopher, and the World Wide Web, and how to access and use them. It discusses online information about women on e-mail lists and World Wide Web sites. Written by Joan Korenman, who has accumulated much experience through running the Women's Studies e-mail list, this manual is a unique resource for identifying information for curriculum transformation on the Internet. Updates to this manual will be available on the World Wide Web at http://www.umbc edu/wmst/updates.html .

130 pages, 6 x 9 hardcover, $20 individuals, $30 institutions, ISBN 1-885303-08-4

➢ ***Funding: Obtaining Money for Curriculum Transformation Projects and Activities***

This manual is intended to assist educators who lack experience in applying for grants but are frequently expected to secure their own funding for projects. The manual provides an overview of the process, basic information and models, and advice from others experienced in fund raising.

150 pages,6 x 9 hardcover, $20 individuals, $30 institutions, ISBN 1-885303-05-x

➢ ***Evaluation: Measuring the Success of Curriculum Transformation***

This manual outlines several designs which could be used when assessing the success of a project. *Evaluation: Measuring the Success of Curriculum Transformation* is written by Beth Vanfossen, whose background in the teaching of research methods as well as practical experience in conducting evaluation research informs the manual's advice. Evaluation is an increasingly important component of curriculum transformation work on which project directors and others often need assistance.

(Available fall 1997)

➢ ***Discipline Analysis Essays***

Under the general editorship of Elaine Hedges, the National Center has requested scholars in selected academic disciplines to write brief essays summarizing the impact of the new scholarship on women on their discipline. These essays identify and explain the issues to be confronted as faculty in these disciplines revise their courses to include the information and perspectives provided by this scholarship. The series is under continuous development, and titles will be added as they become available. See order form for essays currently available.

27 - 60 pages, 6 x 9 paper, $7 each

➢ ***CUNY Panels: Rethinking the Disciplines***

Panels of scholars in seven disciplines address questions about the impact on their disciplines of recent scholarship on gender, race, ethnicity, and class. The panels were developed under the leadership of Dorothy O. Helly as part of the Seminar on Scholarship and the Curriculum: The Study of Gender, Race, Ethnicity, and Class within The CUNY Academy for the Humanities and Sciences. For this seminar CUNY received the "Progress in Equity" award for 1997 from the American Association of University Women (AAUW).

56 - 85 pages, 6 x 9 paper, $10 each

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